INVESTIGATING CHILDHOOD OVERWEIGHT AND OBESITY IN RURAL SETTINGS

A Dissertation

by

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ABSTRACT

Children's risk for overweight and obesity is particularly high in rural areas of the United States. Many health, psychosocial, and economic consequences are associated with childhood overweight and obesity, which concerns health researchers and professionals. But how and why might rural children be more at risk for being overweight and obese? This dissertation investigates childhood overweight and obesity in rural settings through three separate studies.

First, a systematic literature review was conducted to identify determinants and mechanisms of childhood obesity-related behaviors that are specific to rural locations. The findings from the review show that lack of health resources and poverty within the rural environment may impact children's social environment and individual factors. However, results are inconclusive and there continues to be a lack of studies focusing on linking environmental influence with individual factors.

Second, a meta-analysis of current research evidence was conducted to assess the efficacy of rural interventions designed to reduce childhood overweight and obesity. Results showed that interventions have been efficacious yet modest, with a mean effect size of 0.18. Moderating variables were also examined. Mean intervention effect size was moderated by children's age and intervention duration.

Last, secondary data were used to examine the association between rural food stores and availability and affordability of fresh fruits and vegetables. A multilevel analytical approach was used to determine if rural location was associated with availability and affordability of fresh fruits and vegetables. After controlling for other variables, results showed that rural location was not associated with fruit and vegetable availability and affordability.

The findings from this dissertation suggest that the area of rural childhood overweight and obesity remains understudied. More research is needed in order to understand the mechanisms of social ecological influences on diet, physical activity, and childhood overweight and obesity. This area of research, however, is rife with opportunities for public health education and promotion. Public health educators can help promote and advocate for environmental conditions that support healthy lifestyles.

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CHAPTER I

INTRODUCTION

Excess weight among youth in the United States has dramatically increased in the past three decades. The rate of obese children aged two to five years has doubled, and for children aged six to 11 years, it has tripled (Ogden & Carroll, 2010). It is estimated that by 2030, approximately 30% of six to 11 year-olds will be overweight; and by 2074, it will reach to an astounding 50% (Wang, Beydoun, Liang, Caballero, & Kumanyika, 2008).

Such alarming trends are causes of concern for public health researchers and professionals since childhood obesity is associated with many health, psychosocial, and economic consequences. For example, some health complications obese children experience include orthopedic problems, asthma symptoms, and metabolic disorders (Reilly, 2007). Persistence of obesity in adulthood and premature death has also been linked to childhood overweight (Franks et al., 2010; Lobstein, Baur, & Uauy, 2004; Reilly, 2007; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). In addition, obese children are more likely to be socially marginalized (Richardson, Goodman, Hastorf, & Dornbusch, 1961; Strauss, 2003), experience poor self-esteem and body dissatisfaction in later life (Wardle, Waller, & Fox, 2002). In terms of economic consequences, Wang and Dietz (2002) found a substantial increase in percentage of hospital discharges related to children's obesity-associated diseases, which resulted in $127 million spent per year.

The problem of childhood obesity is complex and multi-factorial. The development of excess weight among youth is often attributed to poor dietary habits and sedentary behaviors, and such obesity-related behaviors are highly influenced by external factors. Indeed, certain family and school characteristics have been correlated with excess weight among children (Ebbeling, Pawlak, & Ludwig, 2002).

The physical environment is also implicated in the promotion of overweight and obesity among youth. Studies show that geographic location is independently associated with obesity in children (Singh, Kogan, Van Dyck, & Siahpush, 2008). That is, children of rural residency are disproportionately at risk for being overweight and obese – about 25% are more likely to be of excess weight than children in urban locations (Lutfiyya, Lipsky, Wisdom-Behounek, & Inpanbutr-Martinkus, 2007). This is significant in that 72.1 million children live in rural areas of the U.S. (ERS, 2012); thus, a health disparity among this population exists.

However, the role of the rural environment in children's weight outcomes is not fully understood (Lutfiyya et al., 2007; Sallis & Glanz, 2006). Addressing and investigating this lack of understanding of the rural environment's role in promoting and preventing childhood overweight and obesity is the motivation for this dissertation. This dissertation uses and builds upon current knowledge to examine obesity among youth in rural America. Specifically, the research question of focus is *how and why might children be more at risk for overweight and obesity in rural settings?* Investigating the ways in which rural children may be more at risk for overweight and obesity is important to advancing current knowledge and practice related to health and obesity disparities.

To address this question, the following were conducted: 1) a systematic literature review of determinants and mechanisms of childhood obesity in rural settings; 2) a meta-analysis of interventions for prevention of childhood overweight and obesity among rural youth; and 3) an examination of the association of availability and affordability of fresh fruits and vegetables in rural locations. Thus, the following chapters, II-IV, were written as separate manuscripts.

The first paper examined the literature to identify determinants and mechanisms of childhood obesity that are specific to rural locations. The challenge was to identify factors associated with and pathways that cause obesity among children who reside in rural settings. An understanding of both determinants and mechanisms of childhood obesity specific to rural areas may help to inform health researchers and practitioners, as well as the general public.

The second paper examined the literature to assess the efficacy of interventions that are designed to reduce childhood overweight and obesity in rural settings. The challenge was to quantify the effects of interventions, as well as examine moderating variables that impact interventions for rural youth. Knowing which interventions work enables health researchers and practitioners to implement more evidence-based programs, thus resulting in better health outcomes.

Finally, the third paper examined the association between food stores' location and availability and affordability of fresh fruits and vegetables. The challenge was to determine whether rural location was associated with availability and affordability of fresh fruits and vegetables, in food store environments. Evidence of geographic

disparities in food store environments can help to inform policy recommendations, as well as interventions aimed at improving food environments.

CHAPTER II

THE IMPACT OF RURAL ENVIRONMENT ON CHILDHOOD OVERWEIGHT AND OBESITY: A SYSTEMATIC LITERATURE REVIEW

Introduction

Childhood obesity is on an upward trajectory. In the last 30 years in the U.S., the percentage of obese two- to five- and six- to 11-year-olds has increased from 5.0% to 10.4% and 6.5% to 19.6%, respectively (Ogden & Carroll, 2010). In fact, given the current trends, some suggest that approximately 30% of six to 11 year-olds will be overweight by 2030 (Wang et al., 2008).

This observed trend concerns public health researchers and professionals since childhood obesity has been associated with many health, psychosocial, and economic consequences. For example, children often suffer from asthma symptoms, as well as metabolic disorders due to excess weight (Reilly, 2007). In addition, obese children are more likely to experience social isolation (Richardson et al., 1961; Strauss, 2003), poor self-esteem, and body dissatisfaction in later life (Wardle et al., 2002). And with regards to economic consequences, treatment of children's obesity-associated diseases results in millions of dollars spent per year (Wang & Dietz, 2002).

Understanding the problem of childhood obesity, however, is complex due to its multi-factorial nature. It is highly recognized that poor eating habits and low levels of physical activity as well as sedentary behaviors cause weight gain among youth, and these obesity-related behaviors are influenced by external factors. Indeed, from an

ecological systems theory perspective, children's behaviors cannot be explained effectively without consideration of their context (Bronfenbrenner, 1979). Moreover, an ecological framework (as shown in Figure 1) suggests several levels of influence on children's dietary and physical activity habits, thus, recognizing the inter-relationship between individuals and their environment (McLeroy, Bibeau, Steckler, & Glanz, 1988; Sallis & Glanz, 2006; Story, Kaphingst, Robinson-O'Brien, & Glanz, 2008). Application of this theory and framework as a means of understanding and examining childhood overweight and obesity is prevalent in the literature, with current interest directed towards the role of the physical environment.

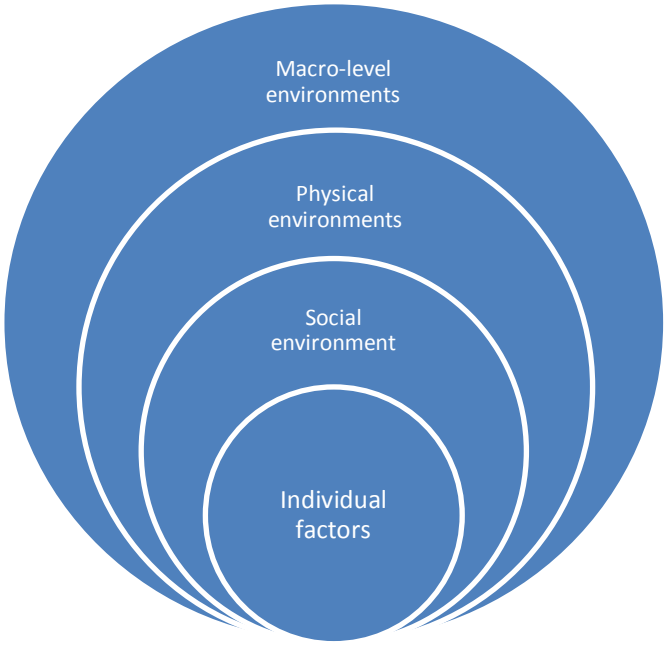

Figure 1. An example of an ecological model.

Indeed, the physical environment may contribute to children's overweight and obese status. For example, studies suggest that geographic location is independently associated with obesity in children (Singh et al., 2008). Children of rural residency are disproportionately at risk for being overweight and obese: 25% of children are more likely to be overweight than children in urban locations (Lutfiyya et al., 2007). This is significant because 72.1 million children live in rural areas of the U.S. (ERS, 2012). However, the role of the rural environment in children's health outcomes is not well understood (Lutfiyya et al., 2007; Sallis & Glanz, 2006).

The research about this topic, though, suggests that rural children may have less access to parks and recreational facilities (Sallis, Prochaska, & Taylor, 2000; Tremblay & Willms, 2003), and live in low-walkable areas (Saelens, 2003), which might make them less likely to be physically active. However, there are some contradictory findings. For instance, Joens-Matre and colleagues (2008) found that rural children were more physically active than urban children, but prevalence of overweight was still higher among the rurally located group. Additionally, dietary habits of children who reside in rural areas are affected, for example, individuals in rural areas are less likely to have access to healthy foods, which in turn leads to poor nutrition (Glanz & Yaroch, 2004; Kaufman, 1999).

Relevant Reviews

A systematic review conducted by Dunton and colleagues (2009) examined the influences of the built and biophysical environment on childhood and adolescent overweight and obesity (see Figure 2). The authors found associations between physical

environmental variables (e.g., vegetation, road safety, availability of bicycle and walking trails, and many more) and children's obese status, which differed by gender, age, socioeconomic status and population density. However, the authors determined that, in general, strong evidence of an association between physical environmental variables and childhood obesity is not yet available.

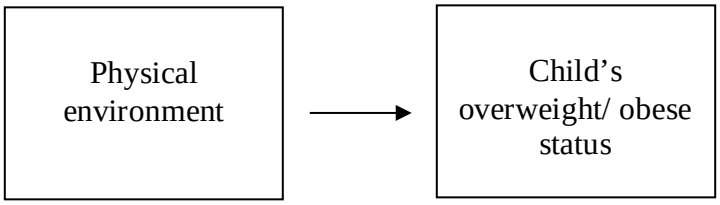

Figure 2. Conceptual model of the review focus of Dunton and colleagues (2009).

Another review examined micro- and macro-environmental determinants of children's physical activity and nutrition (see Figure 3) (Brug & van Lenthe, 2005). The researchers were able to uncover several determinants of children's behaviors, which were categorized as physical, socio-cultural, economic, and political. However, despite the authors' results, they concluded with sentiments similar to that of Dunton and colleagues (2009), and that is, the "…role of the environmental factors as determinants of physical activity and nutrition behaviors is in general not yet convincing" (p. 386). Moreover, the researchers found a few studies that examined rural environmental determinants and children's dietary behaviors, but none examining children's physical activity levels. Of the studies that did include such associations, results were inconclusive (Johnson, Guthrie, Smiciklas-Wright, & Min Qi Wang, 1994; Mazur, Marquis, & Jensen, 2003).

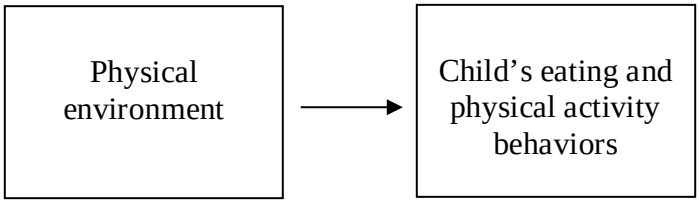

Figure 3. Conceptual model of the review focus of Brug and van Lenthe (2005).

These reviews suggest that certain physical environmental variables are associated with children's nutrition and physical activity, as well as childhood obesity. However, these reviews focused solely on physical environmental determinants of childhood obesity without inclusion of other contextual and individual factors. To the author's knowledge, no review focusing on rural environment as the physical environment is available. Thus, it is important to fill in this research gap: to review studies in which rural environmental, social, and individual factors are studied simultaneously in order to gain more insight about the pathways that lead to childhood obesity-related behaviors and childhood obesity. Identification of such relationships is important for understanding the social ecological influences on physical activity, diet, and children's overweight and obesity, which others have noted is currently lacking in the literature (Sallis & Glanz, 2006; Story et al., 2008).

Purpose

The purpose of this study was to systematically assess the research literature to identify the determinants and underlying mechanisms of obesity-related behaviors that lead to children's overweight and obesity in the *context of the rural environment*. In other words, what is known about how features of the rural environment potentially interact with other factors to influence children's eating and physical activity behaviors, thus, impacting children's weight status (a conceptual model is shown in Figure 4)? A systematic literature review may shed light to research evidence regarding this topic.

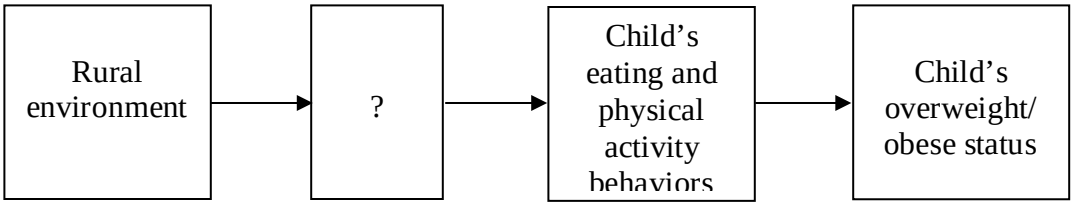

Figure 4. Conceptual model of what is to be examined in this study.

Methods

Search Strategy and Protocol

The following databases were searched for relevant studies: MEDLINE (Ovid), Global Health (Ovid), EMBASE (Ovid), CINAHL (EBSCO), SportsDiscus (EBSCO), and PsycINFO (ProQuest). The search strategy followed Summerbell and colleagues' (2005) protocol with adaptations, such as the inclusion of rural and United States and the omission of keywords related to study design and intervention. Therefore, the key terms of the search were obesity, overweight, body mass index (BMI), child, rural, and the United States. Appropriate MeSH (medical subject headings) tags, synonyms, and truncations were included. Modifications of key terms were conducted based on database-specific criteria.

Inclusion and Exclusion Criteria

Studies were considered for review based on the following criteria. Type of population: studies of children aged 12 years and under or school-based children (pre-kindergarten to sixth grade) were included. Studies of adolescents, with a mean age greater than 12 years, were excluded; however, studies were included if majority of the

participants were children 12 years or younger or if results were presented separately for them. In addition, studies had to be conducted in rural areas of the U.S. Studies located in urban/suburban areas, as well as those in countries other than the U.S. were not part of the inclusionary criteria.

Type of determinants and mechanisms: these terms were not predefined so that the search strategy was not dictated by preconceived ideas about what may or may not be determinants and mechanisms of children's obesity-related behaviors, which would lead to a biased group of studies. However, a study conducted in a rural setting alone, without mention of why or how the rural environment impacts children's weight status, was not a sufficient condition for inclusion.

Type of outcomes: studies that measured children's obesity-related behaviors (related to nutrition and physical activity) as well as measures of overweight and obesity were included; studies that did not report both pieces of information were excluded. Note that this is the reason for not including physical activity and diet and (other variations of these words) as key search terms. In addition, studies that included measures of eating disorders and other medical conditions, such as cardiovascular disease, diabetes, or asthma, as primary outcomes of interest were not included.

Type of studies: both quantitative and qualitative studies were included. Excluded studies were commentaries, editorials, and reviews. Furthermore, studies had to be published between 1980-May 2012; the start year of 1980 was chosen due to the dramatic increase of childhood obesity rates observed in the U.S. (Ogden & Carroll, 2010).

Process of Study Selection

The primary assessment phase consisted of screening abstracts; studies were either included or excluded based on the stated criteria. When abstracts were not available, studies were included in the secondary assessment. The secondary assessment was conducted on the full text of studies. Only articles that described determinants and mechanisms of childhood obesity-related behaviors specific to characteristics of the rural environment were included in the final synthesis.

Methodological Quality

For objective measurement of each article's quality, an adapted version of Russell and Gregory's (2003) criteria were used. Five questions – with dichotomous responses (yes/no) recorded as one and zero – evaluated each study's research question, design, sampling and analytical methods (a copy of this tool is located in Appendix A). The highest quality score an article could achieve was five.

Data Extraction

The matrix method was adopted in order to systematically record components of each study (Garrard, 2007). This matrix comprised the following information: authors' names, journal, year of publication, study purpose, study design, sample characteristics, analytical method, rural definition, theoretical basis, obesity characteristics, obesity measure, and study findings.

Themes involving rural environmental features and other influential factors impacting children's obesity-related behaviors were identified from qualitative studies. For studies that included quantitative data, both statistically significant and non-

significant relationships between children's dietary or physical activity behavior and another variable were included.

Results

Description of Studies

Of the 890 unique articles screened, four studies met the inclusion criteria (see Figure 5) and appear in the final matrix (see Table 1). The studies were peer-reviewed and published within the last ten years, from 2003-2011. Two studies applied a mixed-methods approach (Crooks, 2003; Hartley, Anderson, Fox, & Lenardson, 2011), and two studies utilized qualitative methodology (Davis, James, Curtis, Felts, & Daley, 2008; Seal & Yurkovich, 2009).

Half of the studies focused on dietary behaviors as it related to children's weight status, while one focused on physical activity behaviors and one involved both behaviors. While two studies included children in their study, the other two were of parent-child dyads. Two studies used focus groups to collect data (Davis et al., 2008; Seal & Yurkovich, 2009), while one study collected data through personal interviews (Crooks, 2003). Quantitative data were collected through the use of 24-hour dietary recalls (Crooks, 2003) and household/food questionnaires (Hartley et al., 2011). The sample size of children included in the studies ranged from 10 to 272.

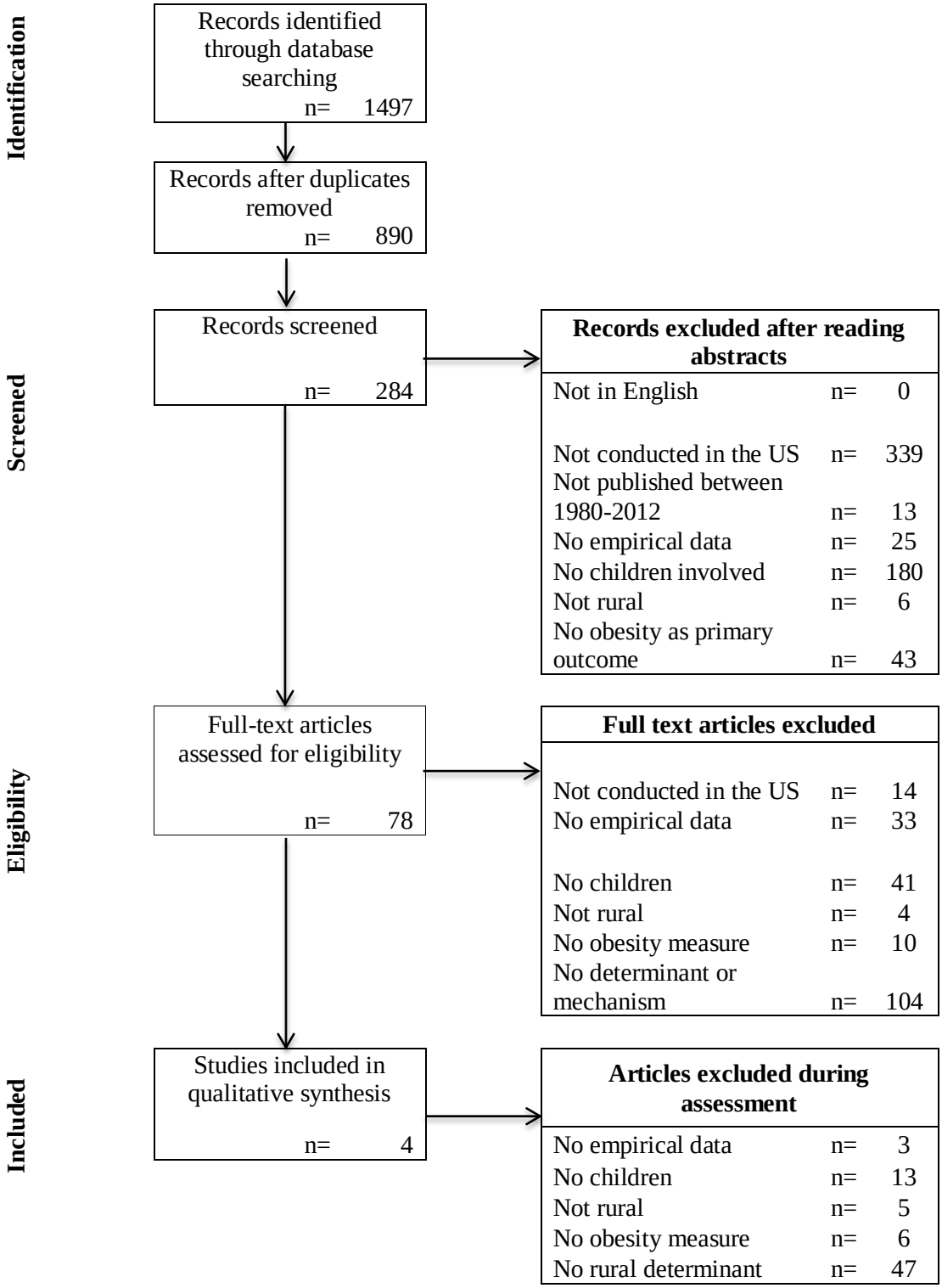

Figure 5. Flow diagram of first study.

Table 1

Systematic Literature Review Matrix

Author(s) and journal title	Year	Purpose	Study design	Sample characteristics	Analytical Method	Rural definition	Theoretical basis	Child overweight / obesity characteristics[a]	Child overweight / obesity measure: subjective or objective?	Findings	Quality score
Crooks Medical Anthropology Quarterly	2003	To examine the association between school snack foods and the growth and nutritional status of school children, in addition to understanding the environmental factors that impact diet	Mixed methods	54 children in grades 3-5 in rural Kentucky	Descriptive statistics	Rural community in eastern Kentucky, the region known as Central Appalachia designated as "severely distressed"	Combination of cultural and biological anthropology theories: biocultural approach	14.8% overweight 18.5% obese	Objective	High poverty impacts the funds allotted to the study site, which leads to the sale of unhealthy snack foods to support educational programs School snacks contribute 134.7 calories to sample children's diets; both overweight boys and girls consumed slightly more school snacks than normal weight children, but only statistically significant for boys	Research question: 1 Research design: 1 Sample method: 1 Data collection: 1 Data analysis: 0 Total score: 4

Table 1 Continued

Author(s) and journal title	Year	Purpose	Study design	Sample characteristics	Analytical Method	Rural definition	Theoretical basis	Child overweight / obesity characteristics[a]	Child overweight / obesity measure: subjective or objective?	Findings	Quality score
Davis, James, Curtis, Felts, & Daley Obesity	2008	To understand parental attitudes concerning childhood obesity, and to learn about barriers to attaining a healthy weight for their children, as well as current services available for weight loss in rural communities	Focus groups	Parent-child dyad 21 parents of children in grades 3-5 in rural Kansa Mean age of parents 38.8±5.1 years Mean age of children 10.8±0.7 years	Thematic analysis	Schools in a town or county of less than 20,000 individuals	None	100% overweight	Subjective Parent report	No weight loss programs for children in rural communities; few outlets for physical activity for the entire family; grocery stores did not offer low-fat and low-calorie foods that are offered in urban stores; distance to primary care doctors was problematic since they are the only source of weight loss information	Research question: 1 Research design: 1 Sample method: 1 Data collection: 1 Data analysis: 1 Total score: 5

Table 1 Continued

Author(s) and journal title	Year	Purpose	Study design	Sample characteristics	Analytical Method	Rural definition	Theoretical basis	Child overweight / obesity characteristics[a]	Child overweight / obesity measure: subjective or objective?	Findings	Quality score
Hartley, Anderson, Fox, & Lenardson Childhood Obesity	2011	To examine the relationship between rural food environment and children's food consumption and overweight and obesity rates in rural Maine	Mixed methods	272 children ages 2-17 years in rural Maine 67.6% of sample aged 2-12 years	Chi-squared tests; t-tests; bivariate statistics; multivariate regression analysis	Rurality was measured using the urban-rural continuum codes at a county level	Ecological model	47.9% of sample was overweight or obese	Subjective Parent report	Travel time to food outlets marginally signification with home food availability; link between home food availability and child's eating behavior, but child eating behavior not predictive of obesity	Research question: 1 Research design: 0 Sample method: 1 Data collection: 1 Data analysis: 0 Total score: 3

Table 1 Continued

Author(s) and journal title	Year	Purpose	Study design	Sample characteristics	Analytical Method	Rural definition	Theoretical basis	Child overweight / obesity characteristics[a]	Child overweight / obesity measure: subjective or objective?	Findings	Quality score
Seal & Yurkovich Online Journal of Rural Nursing and Health Care	2009	To examine parents' and children's physical activity	Focus groups	Parent-child dyad 10 parents of 3-5 year-olds in rural North Dakota Mean age of parents 30 years Mean age of children 4 years	Thematic content analysis	Participants lived within a 50-mile radius of small northern plains town with a population of 97,000	Social cognitive theory	80% overweight 20% obese	Objective	Lack of programs for the whole family to participate in; childcare issues; lack of flexibility in programs that are offered; high cost of physical activities and memberships	Research question: 1 Research design: 1 Sample method: 1 Data collection: 1 Data analysis: 1 Total score: 5

[a] Overweight and obesity are based on current categories designated by the Centers for Disease Control and Prevention (Barlow, 2007).

Methodological Assessment

Two studies received a quality score of five (Davis et al., 2008; Seal & Yurkovich, 2009); one study received a four (Crooks, 2003); and one received a score of three (Hartley et al., 2011). The study conducted by Crooks (2003) received a score of four because the author did not state explicitly how data were analyzed. The author states clearly how data were collected via observations, semistructured and unstructured interviews, but did not go into detail as to how data were recorded and analyzed.

Hartley and colleagues (2011) received a score of three for their study due to inappropriate research design and statistical analyses. In their study, a theoretical causal pathway was suggested but a cross-sectional design was employed. Other researchers have suggested that cross-sectional studies provide the weakest evidence for causal relationships (Bauman, Sallis, Dzewaltowski, & Owen, 2002). Furthermore, a multilevel study design was used but not a multilevel analytical approach. Also, a small sample size was a limitation of their study, especially given the number of predictors included in their models.

Rural Definitions

The studies were conducted in different rural areas of the U.S.: North Dakota, Kansas, Kentucky, and Maine. Overall, studies had a unique way of defining rural. Two studies defined rural in terms of population size as determined by the U.S. Census data (Davis et al., 2008; Seal & Yurkovich, 2009). On the other hand, Crooks (2003) defined rural using qualitative terms such as “severely distressed”, while Seal and Yurkovich

(2009) described rural based on the participants' residential distance (in miles) from an urban clustered area.

Use of Theory and Theoretical Frameworks

Three out of four studies mentioned an explicit theory or theoretical approach (Crooks, 2003; Hartley et al., 2011; Seal & Yurkovich, 2009); each study applied a unique theory. The ecological model was utilized in Hartley and colleagues' study (2011) to examine several constructs that influence behavior. Another theoretical approach, used by Crooks (2003), was a combination of cultural and biological anthropology theories, namely the biocultural approach. The biocultural approach aids researchers in understanding health and nutrition by combining "…ethnography with quantitative measures of human biological outcome to better determine how human/environment interactions shape health and nutritional status" (Crooks, 2003, p. 184). Lastly, the social cognitive theory guided the study by Seal and Yurkovich (2009), which categorized the influences of children's behaviors based on personal and environmental factors.

Findings from Quantitative Data

The studies that reported quantitative data were of children's dietary habits and the factors that influenced these behaviors. In one study, the rural environment feature examined was food outlets (superstores, grocery and convenience stores) (Hartley et al., 2011). It was hypothesized that food outlets (those commonly used by participants) would influence the household food environment which in turn would affect a child's eating behavior, thus, ultimately impacting weight (see authors' conceptual framework).

However, results showed minimal evidence for a link between food outlets and the home food environment. In fact, only travel time to food outlets was found to be marginally significant ($p<0.10$) with home food availability, and not the selection, quality or price of healthy foods in the retail stores. There was evidence for a link between home food availability and children's eating behavior, although children's consumption was not predictive of overweight or obesity.

Another study examined links between poverty prevalent in the rural setting (which was a qualitative finding, therefore, details are presented below) and the school's sale of snack foods on children's nutrition. School snacks contributed extra calories to children's daily diet; overweight boys consumed more school snacks than normal weight boys. Both overweight boys and girls had higher school snack calorie intakes than their normal counterparts, but this finding was only statistically significant for boys.

Findings from Qualitative Data

There were many different themes about the rural environment that emerged from the studies, including lack of weight loss programs, lack of opportunities for physical activity, lack of healthy foods, lack of health resources, and poverty. Two studies mentioned similar features of the rural environment, namely lack of weight loss programs and opportunities for engaging in physical activity (Davis et al., 2008; Seal & Yurkovich, 2009). However, the underlying mechanism for children's lack of physical activity was unique. For example, in Seal and Yurkovich's (2009) study, parents acknowledged that parental modeling (i.e., parents engaging in physical activity themselves) was the reason why children engaged in physical activity. This is in contrast

to Davis and colleagues' (2008) study in which the underlying mechanism for children's physical activity was motivation. Also, parents felt that in order for programs to be successful, they would have to be motivating for children.

Another determinant that was mentioned was lack of health resources. One of the findings from Davis et al. (2008) was distance from primary care physicians was problematic for families in rural settings. A primary care physician was often the only source for weight loss information, and parents reported traveling over an hour to see their physician. Another factor mentioned was lack of healthy foods. Families reported to not having access to low-fat, high-fiber foods and healthy snacks. Moreover, parents noted they often did not have time to fix a nutritious meal.

The study conducted by Crooks (2003) revealed that poverty in the community was a determinant of the sale of snack foods in the school. High poverty in the community contributed to the school's low funding base. Therefore, the sale of snack foods provided additional funds for programs that were perceived to be fundamental to children's education, especially for children who came from poor families.

Discussion

Summary of the Evidence

The goal of this study was to examine the current literature to identify determinants and mechanisms of children's obesity-related behaviors that lead to their current overweight and obese status. There is evidence suggesting that rural children are more likely to exhibit obesity-related behaviors than urban children (Liu, Jones, Sun,

Probst, & Cavicchia, 2010). But what interacts with the rural environment that impacts children's obesity-related behaviors which leads to childhood overweight and obesity? The qualitative evidence included in this review suggest that lack of resources within the rural environment might impact children's more immediate environment such as their school, and the social environment such as their parents, in addition to children's individual factors such as motivation.

In essence, there are external forces beyond and within parents' and children's control that potentially impact children's obesity-related behaviors and weight status. For example, the lack of access to healthy foods compounded with parents' lack of time impacts parents' ability to provide healthy nutrition for their children. Other factors such as poverty, lack of opportunities for physical activity, and lack of access to health professionals also play a role. However, it's unclear whether these forces affect each family equally, and which rural environmental variables have the most impact on children's nutrition and physical activity.

Despite such qualitative findings, quantitative assessments by Hartley and colleagues (2011) suggest there is no evidence (if taking into consideration $p<0.05$) linking rural environmental variables to household variables to children's behavior, and ultimately, to children's weight status (Hartley et al., 2011). Possible reasons for non-significant results could be the study's small sample size or the analyses employed by these researchers; perhaps, a multilevel analysis would have been more useful.

Overall, similar to others' findings (Brug & van Lenthe, 2005; Dunton, Kaplan, Wolch, Jerrett, & Reynolds, 2009), the exact role of the rural environment is still

unclear. Some of the findings in this present study are consistent with previous research, including lack of facilities and opportunities for physical activity. However, this review was unique in that its sole focus was on children's obesity-related behaviors and obesity in rural settings. This study was able to provide insight to how lack of opportunities for physical activity impacted children's weight status. Unfortunately, childhood obesity in rural settings is still an understudied area of research. Lacking in the current literature is an examination of multiple levels of influence of children's obesity-related behaviors, especially one that includes the individual unit.

To date, current research suffers from a lack of well-defined theories/theoretical models and appropriate analyses to test such theories and models. Other obesity researchers have called for better study designs and analytic strategies for environmental research related to obesity, which involves understanding multilevel methods and analyses (Sallis, Story, & Lou, 2009).

Furthermore, studies often do not have a uniform definition of rural settings, yet this problem is not new. Researchers have called for better ways to define rural, which is essential for public health research and for health policy makers (Hart, Larson, & Lishner, 2005; Isserman, 2005). Indeed, making sure that rural is defined correctly ensures that the government programs reach the right people, places and businesses (Isserman, 2005). In order to advance research in this area, a consensus on what defines rural is needed.

Limitations of the Evidence

This systematic literature review included a small number of studies due to the stringent criteria as stated before. This study focused on children in rural areas of the U.S. and included studies that measured children's weight status. These four criteria alone excluded about 74% of the articles identified through the search. It is possible to have relaxed on some of the criteria, such as including studies that did not have measures of overweight and/or obesity or including older children. However, making such changes would have defeated the study's purpose, which was to examine the features of the rural environment (combined with other variables) to understand its influence on children's obesity-related behaviors that impact children's weight status. Another limitation of this review was the use of a single reviewer, which can lead to bias when selecting relevant articles for review.

Most of the studies included in this review were qualitative, which was informative, but unfortunately, did not provide evidence about children's actual health behaviors. Also, these qualitative studies included a small sample of parents (of young children) from certain demographic characteristics (e.g., parents had some college or were college-educated), so the findings may differ for families from different backgrounds. However, these studies did provide insight to underlying mechanisms, which aided in the understanding of how rural determinants might impact other factors that in turn affect children's health behaviors. Understanding of underlying mechanisms is a first step in the building and refinement of more appropriate theories for understanding children's obesity-related behaviors and obesity.

Moreover, the quantitative study included in this review relied on parent-reported data of children's eating behavior. Parents may have reported what they believe to be socially acceptable responses. In addition, in two studies, parents' report of children's height and weight were used to calculate BMI, which may be subject to bias.

Conclusions

Unique to this study was the simultaneous examination of multiple levels of influence with regards to children's obesity-related behaviors and weight status, which adds to body of literature. Unfortunately, not many studies have examined the contextual facets of children's obesity-related behaviors and childhood obesity in rural settings. Indeed, there continues to be a lack of evidence in the literature regarding the exact role of the rural environment in children's eating and physical activity behaviors that lead to overweight and obese status.

Children often are not equipped to make individual changes in terms of diet and physical activity. This present study shows that children need the support of their social, physical, and macro environments. A better understanding of determinants and mechanisms of obesity among rural youth can help to inform future research and research methodology, as well as to better implement health interventions that are designed to reduce childhood overweight and obesity in rural settings.

CHAPTER III

INTERVENTIONS FOR CHILDHOOD OVERWEIGHT AND OBESITY IN RURAL AREAS OF THE U.S.: A META-ANALYSIS

Introduction

Childhood obesity rates continue to increase in the United States. The prevalence of obesity in children aged two to five years has doubled in the last three decades (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). For six- to 11-year-olds, the rate has increased from 6.5% to 19.6% (Ogden et al., 2010). If current efforts to curb the rate of overweight children are not successful, then the rate is estimated to increase to 30% in about 20 years (Wang et al., 2008).

These trends are problematic because childhood obesity is associated with serious consequences. Overweight children suffer from many health, psychosocial, and economic complications. Children often experience orthopedic problems, asthma symptoms, and metabolic disorders (Reilly, 2007) due to excess weight, as well as obesity in adulthood, which can lead to premature death (Franks et al., 2010; Lobstein et al., 2004; Reilly, 2007; Whitaker et al., 1997). In addition, obese children are more likely to experience psychosocial consequences, which include social marginalization (Richardson et al., 1961; Strauss, 2003), poor self-esteem and body dissatisfaction (Wardle et al., 2002). There are also economic consequences of caring for an overweight child. Studies suggest that hospitalization of children's obesity-related diseases result in millions of dollars spent per year (Wang & Dietz, 2002).

Although studies suggest excess weight among youth may have genetic links (Farooqi & O'Rahilly, 2000; Herbert et al., 2006), it is more often attributed to unhealthy eating and physical inactivity. These obesity-related behaviors are often influenced by other factors as suggested by the ecological systems theory (Bronfenbrenner, 1979). Briefly, the ecological systems theory posits that behavior is reflective of an individual's context or environment, which consists of multiple layers. Furthermore, building upon this theory, an ecological framework suggests several levels of influence on children's dietary and physical activity habits including the social, physical and macro-level environments (McLeroy et al., 1988; Sallis & Glanz, 2006; Story et al., 2008).

Indeed, research studies have applied an ecological perspective as a means of understanding and examining childhood overweight and obesity, and current interest has focused on the role of the physical environment. For example, rural location has been shown to be an independent risk factor in determining child weight status (Lutfiyya et al., 2007). That is, children who reside in rural areas of the U.S. are about 25% more likely to have excess weight than their urban counterparts (Lutfiyya et al., 2007). This is a significant problem given that 72.1 million children live in rural America (ERS, 2012).

Because child obesity rates are increasing at such an alarming rate, many public health researchers and practitioners have focused their efforts on strategies to reduce childhood obesity. Given that children of rural locations are more at risk for overweight and obesity, interventions promoting healthy lifestyles and weight loss in these areas are more important than ever. However, weight loss interventions in children have not been successful (Edmunds, Waters, & Elliott, 2001). In fact, most interventions have failed to

demonstrate effects on preventing weight gain (Heitmann, Koplan, & Lissner, 2009). Summerbell and colleagues (2005) concluded with a similar sentiment, *"…the interventions employed to date, have, largely, not impacted on weight status of children"* (p. 37).

Relevant Meta-Analyses

In contrast, though, a published meta-analysis assessing several interventions designed to reduce weight (in terms of pounds lost) among children found a statistically significant positive (and relatively large) effect, d=0.95 (Snethen, Broome, & Cashin, 2006). Moreover, that meta-analysis found interventions implemented at longer durations tended to have larger effects for weight loss, although the statistical correlation between the two was low. However, others show no evidence of a relationship between duration and impact of intervention (Seo & Sa, 2010; Stice, Shaw, & Marti, 2006; Wilfley et al., 2007).

In another meta-analysis conducted by Seo and Sa (2010), the researchers examined obesity interventions for minority children in the United States. They found that interventions consisting of three or more components (related to energy expenditure or consumption, counseling or medication) to reduce weight status were more efficacious than interventions with fewer components. In addition, lifestyle interventions, ones that incorporated changes in diet and physical activity, and interventions with parental involvement were also more efficacious.

Other findings from previous meta-analyses of interventions for reducing weight among children have been inconclusive. Some found evidence for efficacy of

interventions (Seo & Sa, 2010; Wilfley et al., 2007), while some meta-analyses have not (Gonzalez-Suarez, Worley, Grimmer-Somers, & Dones, 2009; Stice et al., 2006). For example, Wilfley and colleagues (2007) found substantial effects, in terms of weight loss, for interventions that treated childhood overweight – the mean effect size for the intervention studies included in their meta-analysis was 0.75. However, another meta-analysis examining school-based interventions for childhood obesity showed that intervention programs were not effective (Gonzalez-Suarez et al., 2009), even though the same measures for determination of effects (i.e., BMI) were used.

Purpose

Despite what is known about interventions for treating and preventing childhood obesity, there has not been an assessment of obesity prevention programs for children in rural settings. The purpose of this study was to quantitatively evaluate the efficacy of interventions focused on obesity prevention, which was defined as a program that resulted in weight loss or weight control for youth in rural settings. It was hypothesized that interventions for childhood obesity in rural settings will be efficacious similar to the results found by others (Stice et al., 2006; Wilfley et al., 2007). Secondary aims were to examine variables that potentially moderated intervention outcomes (if appropriate), including type of control groups used, number of components in the intervention, duration of the intervention, and participants' age.

Methods

Meta-Analysis

This study was a meta-analysis of obesity prevention programs among youth residing in rural locations. Briefly, a meta-analysis is a form of survey research in that research reports, and not individuals, are surveyed (Lipsey & Wilson, 2001). Meta-analysis "…focuses on the aggregation and comparison of the findings of different research studies" (Lipsey & Wilson, 2001, p. 2).

Search Strategy and Protocol

This study utilized an adapted version of an existing search strategy (Summerbell et al., 2005), and the following databases were searched for relevant studies: MEDLINE (Ovid), Global Health (Ovid), EMBASE (Ovid), CINAHL (EBSCO), SportsDiscus (EBSCO), and PsycINFO (ProQuest). The key terms of the search were obesity, overweight, child, rural, and the United States. When appropriate, MeSH (medical subject headings) tags, synonyms, and truncations were used. Key terms were modified based on specific requirements of particular databases.

Inclusion and Exclusion Criteria

Studies were included in the meta-analysis based on the following criteria: 1) studies included children aged 12 years and under or school-based children, and were conducted in rural areas of the U.S.; 2) interventions that were lifestyle, behavioral or educational in nature; 3) studies reported outcome measures such as zBMI, BMI, percent overweight, or BMI percentile (Seo & Sa, 2010); 4) studies had to be randomized controlled trials or matched at baseline for participant characteristics; and 5) studies had

a control or comparison group, that is, individuals who did not receive the intervention or received minimal components (the control condition should not represent a concentrated effort to produce change), or were assigned to a wait list.

Randomized controlled trials were optimal since they take into account confounding variables, and any effect observed between groups can be linked to the intervention. However, inclusion of studies that carefully selected comparison groups was also acceptable because such studies allow for useful inferences regarding intervention effects (Shadish, Cook, & Campbell, 2001). Furthermore, studies had to be published between 1980-May 2012; the start year of 1980 was chosen due to the dramatic increase of childhood obesity rates observed in the U.S. (Ogden et al., 2010).

Studies were excluded based on the following criteria: 1) studies that examined adolescents, mean age of study participants greater than 12 years, and urban/suburban and countries other than the U.S.; 2) interventions that treated eating disorders or medical conditions such as cardiovascular disease, diabetes, or asthma; 3) studies that used self-reported measurements of height and weight and BMI; and 4) qualitative research, as well as articles describing development and methods of an intervention.

Process of Study Selection

Study selection consisted of two phases: 1) screening abstracts, and including or excluding articles based on the stated criteria; and 2) reading the full text of studies for fit of all inclusionary criteria. When abstracts were not available, studies were included in the secondary assessment. Only studies of controlled interventions for weight loss or weight control among youth in rural settings were included. This means that studies in

which participants were assigned to an intervention or to a no-treatment or wait-list control, as well as to a group that received usual programming (e.g., standard physical education or nutrition classes) were included.

Methodological Quality

Each article was assessed for quality based on an adapted version of the Joanna Briggs Institute (JBI) Critical Appraisal Evidence Effectiveness tool, which has been used in a previous meta-analysis (Gonzalez-Suarez et al., 2009). There were ten questions in total that assessed a study's methodology (a copy of the list of questions is in Appendix B). The questions were based on each study's group assignment, attrition characteristics, outcome measurement, follow-up methods, and appropriate statistical analysis. The quality score ranged from zero to ten, with ten being the highest. A study with a score of six and above was deemed to be of appropriate quality based on previous research (Gonzalez-Suarez et al., 2009).

Data Extraction

A coding document was developed to systematically record components of each study. The variables that were extracted from the articles were categorized into substantive and methodological (a copy of this document is attached in Appendix C) (Lipsey & Wilson, 2001). Examples of substantive variables include type of interventions, children's age, and duration of intervention. Examples of methodological variables include survey design, attrition rate, and nature of control group. This information was also presented in a matrix format (Garrard, 2007).

Statistical Analysis

Selection and calculation of effect sizes. Some studies reported multiple measures of weight loss, but for this present meta-analysis, only one measure was used to calculate each effect. The following measures were used in descending priority: 1) zBMI, 2) BMI, 3) BMI percentile. The advantage of using these outcome measures is that they take into account children's weight and height (Wilfley et al., 2007).

Cohen's *d* was used to calculate effect sizes, which is appropriate given that the difference between two means is being compared (i.e., main outcome measures related to weight status between experimental and control groups). This is also a suitable metric for studies with different designs, and has been used by others (Seo & Sa, 2010; Snethen et al., 2006). The *d*-indices were calculated by dividing the difference in main outcome measure changes between the two groups by the pooled standard deviations of the change scores:

$$d = \frac{(\text{mean change for the control-mean change for the intervention})}{\text{change score standard deviation}_{\text{pooled}}}$$

Thus, positive values would indicate a better outcome for the intervention group.

Whenever standard deviations of the change scores were not reported, baseline pooled standard deviations were used. Prior to analysis, Cohen's *d* was transformed to Hedges' *g* in order to account for small sample bias (Lipsey & Wilson, 2001). Thus, each effect size was weighted by the inverse of its variance before computation of the mean effect size. For studies that did not report means and standard deviations, *d*-indices

were estimated from the significance levels of statistical tests using formulas provided by Lipsey and Wilson (2001).

Homogeneity analysis (Q-statistic). The Q-statistic was used to test whether a set of effect sizes was homogeneous; this statistic determines whether the observed variance in effect sizes was different from that of sampling error alone (Cooper, 2009). If the results suggested heterogeneity (i.e., the Q-statistic was statically significant at $p<0.05$), then moderating variables were examined via a weighted regression analysis (Lipsey & Wilson, 2001). Analyses were conducted under a fixed and random effects model of error.

Data analyses were conducted using the macros created by Lipsey and Wilson (2001) for SPSS. Analyses included calculation of weighted effect sizes along with 95% confidence intervals, homogeneity analysis, and weighted regression analysis.

Results

Description of Studies

A total of 1497 articles were identified through the search, and one article was identified through the reference of another article. Thus, a total of 891 articles were screened, and seven of those articles were used in the present meta-analysis (see Figure 6 and Table 2). The majority of the articles were published within the last ten years (n=6) (Carrel et al., 2005; Dennison, Russo, Burdick, & Jenkins, 2004; Greening, Harrell, Low, & Fielder, 2011; Janicke et al., 2008; Smith, 2011; Williamson et al., 2012). Only one study utilized a non-randomized comparison group (Donnelly et al., 1996); the rest

were randomized controlled trials. Two articles functioned as two separate studies each so that the total number of interventions was nine (Janicke et al., 2008; Williamson et al., 2012). The seven studies included a total of 1783 participants in nine different interventions and 898 participants in seven different control groups.

With the exception of one study, all interventions were school-based (as shown in Table 2). Studies represented different rural areas of the U.S. The average age of participants was 8.95 years, with a range 2.6 to 14 years. Four studies had a majority of White females as participants, two studies had a majority of African-American children, and another two had a male majority. The majority (n=4) of the studies did not incorporate theory or any theoretical framework in their study. The duration of interventions ranged from 7 to 121.8 weeks, with an average of 47.5 weeks. The attrition rates (for the studies that reported it) ranged from 11% to 43.8%, with an average attrition rate of 17.1%.

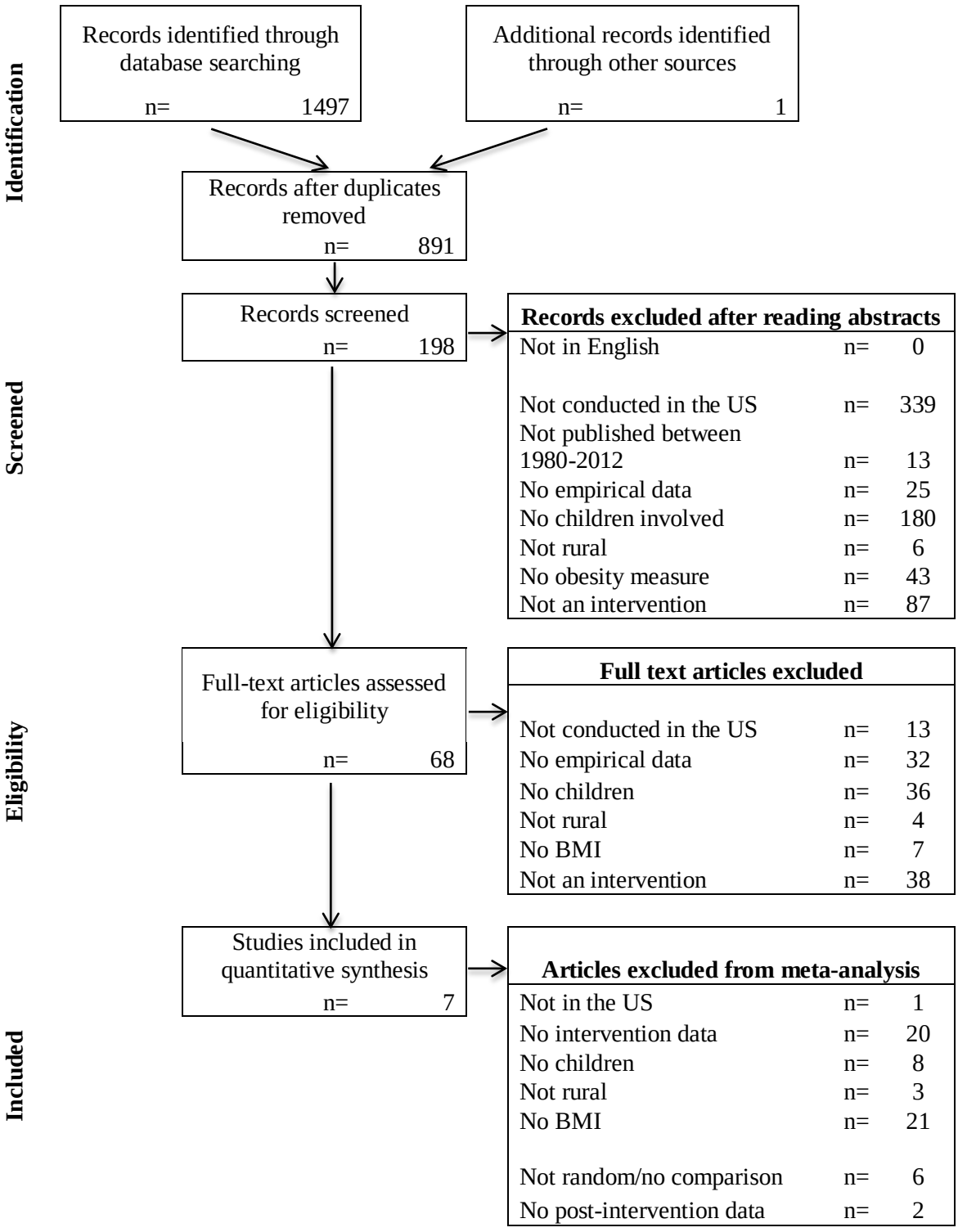

Figure 6. Flow diagram of second study.

Table 2

Meta-Analysis Matrix

Author(s)	Year	Study design	Theory-based	Setting	Sex	Race/ Ethnicity	Mean age (Range)	Type of intervention	Sample size[a]	Attrition rate	Duration of intervention	Quality score
Carrel et al.	2005	Randomized controlled trial	No	School in rural Wisconsin	>50% M	Not reported	12	1. Increase PA, increase healthy eating habits (lifestyle-focused, fitness-oriented classes) 2. Traditional PA control	27 23	0%	39.1 weeks	6
Dennison et al.	2004	Randomized controlled trial	No	Preschool/Day care center in rural upstate New York	>50% F	>60% W	3.9 (2.6-5.5)	1. Curriculum to reduce television viewing, parental involvement 2. Health information control	93 83	43.8%	7.0 weeks	5

Table 2 Continued

Author(s)	Year	Study design	Theory-based	Setting	Sex	Race/ Ethnicity	Mean age (Range)	Type of intervention	Sample size[a]	Attrition rate	Duration of intervention	Quality score
Donnelly et al.	1996	Non-randomized controlled trial	No	School in rural Nebraska	Not reported	>60% W	9.2	1. Increase PA, increase healthy eating habits, modified school lunch	102	Not reported	104.4 weeks	4
								2.Traditional lunch and PA control	236			
Greening et al.	2011	Randomized controlled trial	Yes	School in rural Mississippi	>50% M	>60% AA	8.3 (6-10)	1. Increase PA, increase healthy eating habits, parental involvement, institutional change (replaced deep frying equipment with baking ovens)	204[b]	11%	34.8 weeks	5
								2. Standard nutrition education and PA control	246[b]			

Table 2 Continued

Author(s)	Year	Study design	Theory-based	Setting	Sex	Race/ Ethnicity	Mean age (Range)	Type of intervention	Sample size[a]	Attrition rate	Duration of intervention	Quality score
Janicke et al.	2008	Randomized controlled trial	No	Family-based, four rural counties	>50% F	>60% W	11.4 (8-14)	1. Increase PA, increase healthy eating habits, parental involvement, behavior modification	33	12.9%	17.4 weeks	7
							11.0	2. Parental involvement	34 26			
								3. Waitlist control				
Smith	2011	Randomized controlled trial	Yes	School in a rural Appalachian district	>50% F	>60% W	9.8 (8.5-12)	1. Increase PA, increase healthy eating habits, behavior modification	37 35	Not reported	8 weeks	6
								2. Information control				

Table 2 Continued

Author(s)	Year	Study design	Theory-based	Setting	Sex	Race/ Ethnicity	Mean age (Range)	Type of intervention	Sample size[a]	Attrition rate	Duration of intervention	Quality score
Williamson et al.	2011	Randomized controlled trial	Yes	School in rural Louisiana	>50% F	>60% AA	10.5	1. Increase PA, increase healthy eating habits, parental involvement	713	17.6%	121.8 weeks	6
							10.5		760			
								2. Increase PA, increase healthy eating habits, parental involvement, internet counseling	587			
								3. No-treatment control				

[a]Baseline sample size.
[b] Post-treatment sample size (study did not report baseline *n* for groups).

Methodological Assessment

Four out of the seven studies received a quality score of six or above indicating that in general studies employed sound research methodology (Carrel et al., 2005; Janicke et al., 2008; Smith, 2011; Williamson et al., 2010). The scores ranged from four to seven. Of the studies that scored five or less, statistical analyses used were not indicated clearly (Dennison et al., 2004; Greening et al., 2011), and in one case randomization was not applied (Donnelly et al., 1996). Most studies also did not conduct a follow-up assessment (Carrel et al., 2005; Dennison et al., 2004; Donnelly et al., 1996; Greening et al., 2011; Smith, 2011).

Effect Sizes and Q-Statistic

The nine effect sizes calculated (as Cohen's *d*) ranged from -0.19 to 0.86 (see Figure 7). Note that a table of the calculations of effect size is provided in Appendix D. There were only two studies that had statistically significant positive intervention effects based on $p<0.05$ (Dennison et al., 2004; Janicke et al., 2008). The average effect size was small, $g=0.18$, but was statistically significant (confidence interval (CI)=0.03, 0.33, $p<0.05$). Note that *d*-indices were weighted, Hedges' *g*, prior to analysis of overall effect size as mentioned in the methods. Overall, the mean effect size tended to favor the intervention group.

The Q-statistic (20.73, df=8, $p<0.01$) indicated variability among effect sizes, which could be produced by characteristics of the interventions. Thus, moderating variables were examined. Four continuous moderators were assessed: type of control groups used (ranging from a no-treatment to a two-component control, coded as 0 to 2),

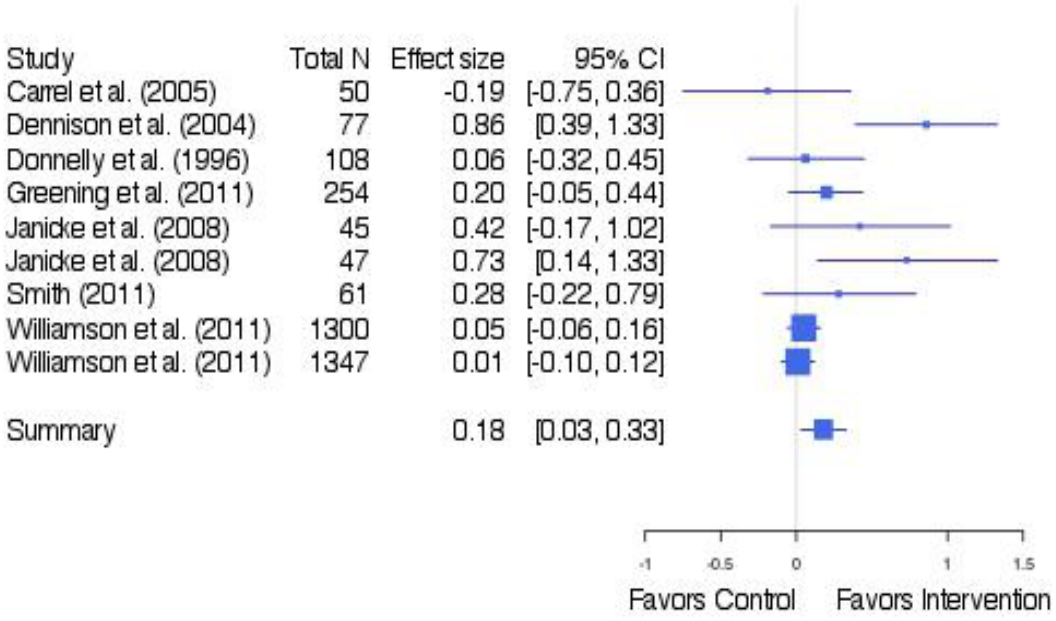

Figure 7. Effect size of each study and weighted mean effect size and confidence intervals.

number of components included in the intervention (ranging from 1 to 4), length of the intervention (ranging from 7 to 121.8 weeks), and age of children (mean age of participants was used and ranged from 3.9 to 12 years).

Moderator Analyses

The regression model employed to assess the effects of the moderator variables upon the average effect size explained significant variability in the effect sizes, and the residual suggested that unexplained variability was no greater than what would be expected from sampling error (with a model R^2=0.87). A one standard deviation increase in the variable "control group" resulted in a 0.57 standard deviation decrease in mean intervention effect size, that is, an increase in the number of control components resulted in a decrease in mean intervention effect size. However, this was only marginally significant (p<0.10).

The number of components included in the intervention did not moderate the mean intervention effect size (z=-0.78, β=-0.18, p >0.10). The duration of intervention did moderate mean intervention effect size. A one standard deviation increase in the variable "duration" resulted in a 0.73 standard deviation decrease in mean intervention effect size, that is, longer interventions resulted in a decrease in mean intervention effect size. An exploratory graph of this result is shown in Figure 8. The age of participants also moderated mean intervention effect size. The mean intervention effect size decreased as the age of participants increased (z= -2.07, β= -0.61, p <0.05).

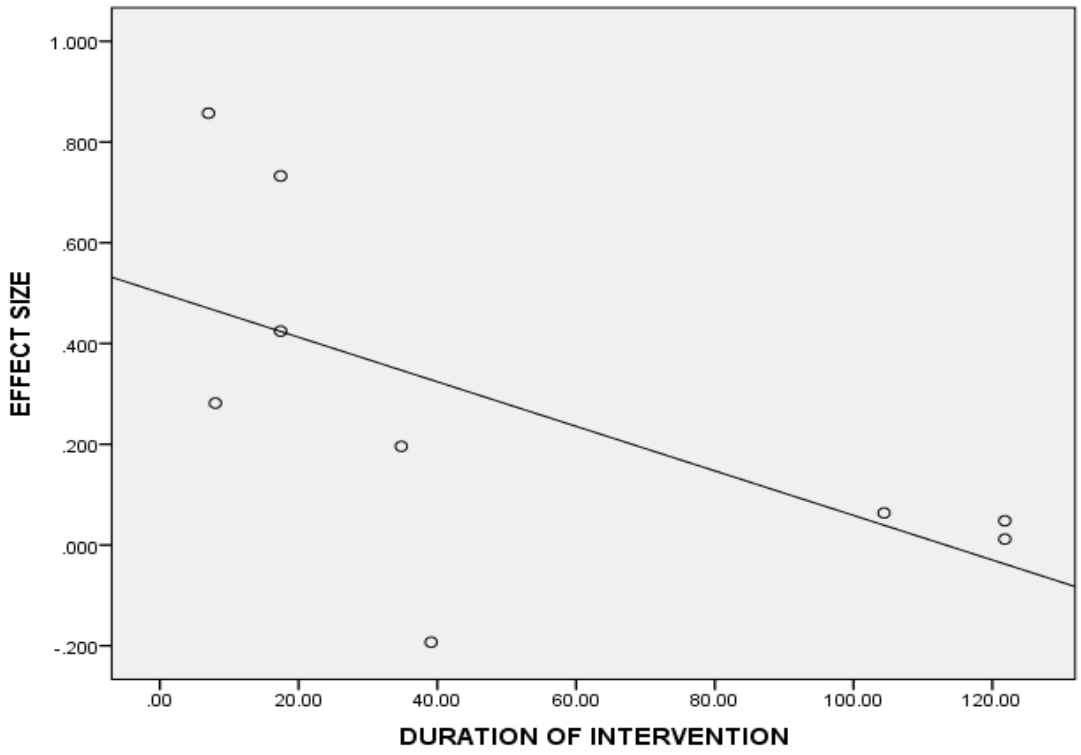

Figure 8. Plot of study-specific effect size and duration of intervention (with best fit line).

Discussion

Summary of the Evidence

The purpose of this meta-analysis was to examine the efficacy of interventions that aim to reduce childhood overweight and obesity in rural settings. The results showed that interventions have been efficacious, with a modest overall mean effect of 0.18 (CI=0.03, 0.33). Some interventions resulted in a higher effect size than others. For example, the study conducted by Dennison and colleagues (1996) had the largest effect size, d=0.86. In that study, researchers implemented an intervention designed to reduce television viewing in children, with the help of the parents. However, surprisingly, the intervention with the second highest effect size only consisted of parental involvement suggesting that the inclusion of parents in interventions is important (Janicke et al., 2008).

Moderating variables were examined as a result of the heterogeneity of the effect size distribution. The variable "type of control groups" did not explain the variability across effect sizes, which is similar to previous findings (Wilfley et al., 2007). The number of intervention components also did not account for the variability of observed effect sizes. This is contrary to another meta-analysis that found an increase in intervention components produced better weight loss outcomes (Seo & Sa, 2010). However, such results could be due to the fact that younger children (elementary school children) find it more difficult to understand multiple concepts and skills taught in interventions than middle or high school students (Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2002).

The other moderating variables examined, length of intervention and mean age of participants, did explain variability across effect sizes. Longer interventions resulted in a decrease in overall intervention effects. Prior meta-analyses have found similar results noting that shorter durations typically work best because intervention effects are likely to attenuate over time (Seo & Sa, 2010; Stice et al., 2006).

In addition, weight loss intervention effects tended to decrease as age of the participants increased, which is inconsistent with evidence from other researchers (Stice et al., 2006). However, that meta-analysis by Stice and colleagues (2006) compared children with preadolescents and adolescents. This present meta-analysis included preschool and school-based children (i.e., children 12 years and under). Interventions with children age zero to five years have been shown to be effective in changing some obesity-promoting behaviors (Campbell & Hesketh, 2007).

Overall, interventions for childhood obesity in rural settings seem promising. This present meta-analysis shows that health researchers and practitioners could perhaps implement shorter interventions in younger children in order to combat and prevent overweight and obesity in rural settings. Unfortunately, there is no universal recommendation for the type of components that interventions should include in order for programs to be effective. Because there is a lack of current interventions focusing on childhood obesity in rural settings, more research in this area is needed.

Limitations of the Evidence

This study had a small sample of studies; therefore, the results should be interpreted with caution. The small sample may be due to the stringent criterion that a

study had to be conducted in a rural setting. However, there are many ways to define rural, and this present study attempted to be exhaustive in its search for interventions in rural settings, but it may be the case that not all studies were included. In addition, several articles (n=9) were excluded because they were development pieces of ongoing interventions meaning that this meta-analysis can be updated once these studies conclude.

Despite limiting this meta-analysis to randomized controlled trials, there were insufficiencies in data reporting, which made it difficult to conduct further analyses or examine other moderators. Demographic data were missing such as participants' ethnicity and sex, which are important factors to assess. Also, authors need to report the confidence intervals or standard deviations of the main outcome measures of their study in order for researchers to compute effect sizes.

This study included relevant articles that measured weight outcomes in terms of BMI, excluding other measures such as waist to hip ratio or skinfold thickness. Although BMI may not necessarily be the best measure of obesity, research shows it tends to be the most stable and reliable (Cole, Faith, Pietrobelli, & Heo, 2005). Also, the majority of the studies were school-based interventions. Future studies should include interventions that are conducted in different settings such as home-based interventions (if possible). Another limitation was the use of a single reviewer/meta-analyst, which can increase the risk of bias.

Conclusions

The results show that interventions for prevention of childhood obesity in rural settings are efficacious, but effects are modest. The duration of intervention as well as age of children moderated intervention effects, that is, shorter interventions with younger children resulted in an increase in mean intervention effect size. Future interventions should keep this in mind, especially given the implications, such as the costs of implementing longer versus shorter interventions. This present meta-analysis did not compare interventions conducted in rural versus urban settings, which can be a potential area of research focus.

CHAPTER IV

AVAILABILITY AND AFFORDABILITY OF FRESH FRUITS AND VEGETABLES IN RURAL COUNTIES: A MULTILEVEL ANALYSIS

Introduction

Childhood overweight and obesity has increased in the past three decades in the U.S. (Ogden & Carroll, 2010). However, not all children are affected equally. For example, a disparity exists among overweight and obese children in rural and urban areas. Rural children are approximately 25% more likely to be of excess weight than that of urban-dwelling children (Lutfiyya et al., 2007), and this is significant because 72.1 million children live in rural settings (ERS, 2012).

This pattern is problematic because childhood obesity has been associated with serious consequences that include health, psychosocial, and economic. Due to excess weight, children often suffer from other health problems, such as asthma and metabolic disorders (Reilly, 2007). Overweight and obese children are also more likely to be overweight and obese as adults who suffer from comorbidities, which can lead to an untimely death (Franks et al., 2010; Lobstein et al., 2004; Reilly, 2007; Whitaker et al., 1997). In addition, obese children are more likely to experience social marginalization (Richardson et al., 1961; Strauss, 2003), poor self-esteem, and body dissatisfaction (Wardle et al., 2002). Lastly, the economic consequences of caring for an overweight child are of great magnitude – millions of dollars are spent per year in treating children's obesity-related diseases (Wang & Dietz, 2002).

There is a myriad of known causes of excess weight among youth, which have largely been attributed to unhealthy eating and physical inactivity. And according to an ecological perspective, different levels of influence impact these obesity-behaviors (McLeroy et al., 1988; Sallis & Glanz, 2006; Story et al., 2008). For example, several studies examined the relationship between supermarkets and body weight and found an increase in supermarket availability was associated with an increase in intake of fruits and vegetables and higher quality diets (Laraia, Siega-Riz, Kaufman, & Jones, 2004; Morland, Wing, Diez Roux, & Poole, 2002). However, these studies were conducted with adults.

For children, studies showed that parent feeding styles and the types of food available in the home were associated with overweight and obesity (Campbell et al., 2007; Faith, Scanlon, Birch, Francis, & Sherry, 2004). This may be due to parental lack of nutritional knowledge or lack of access to healthy foods, especially in rural areas (Glanz & Yaroch, 2004; Kaufman, 1999; Variyam, 2001). In addition, studies found that retail food environments impact obesity by having more available and affordable healthy foods at supermarkets or large grocery stores as compared to small grocery stores (Bodor, 2008; Chung & Myers, 1999). However, these studies were conducted in metropolitan/urban areas. A more recent study of food stores, availability and food cost in a rural area found that availability of healthy foods was much higher in supermarkets and grocery stores, but foods at these larger stores tended to be more expensive than smaller stores (Liese, 2007).

Furthermore, studies show that increasing children's intake of fruits and vegetable may protect against overweight and obesity (Epstein et al., 2001). Indeed, because fruits and vegetables are high in fiber and water, incorporating them into children's diets would promote satiety, reduce energy density, and decrease energy intake. Thus, access to and consumption of fruits and vegetables can perhaps aid in combating overweight among children in rural settings.

The WIC Program

The U.S. government provides nutrition information and supplemental foods to low-income pregnant and post-partum women and their children who may be at nutritional risk through the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) (FNS USDA, 2012). Prior to 2009, WIC food packages did not include fresh fruits and vegetables. However, policy changes to the WIC program provided low-income families the ability to purchase fruits and vegetables and other healthy foods they did not have previous access to. The WIC program's reach is expansive; in fact, during the fiscal year of 2011, WIC served approximately 9.17 million women and children (FNS USDA, 2012).

Purpose

This study aims to examine the association between rural location and availability and affordability of healthy foods in food stores, specifically fresh fruits and vegetables. Although similar studies have reported such findings, this study was unique in that no study has examined the availability and affordability of foods that individuals enrolled in WIC have access to. This study aims to answer the following question: Do

food stores in rural counties have less available and affordable fresh fruits and vegetables?

Methods

Sample

This study was a secondary data analysis of the WIC component of a larger project, the Texas Childhood Obesity Prevention Policy Evaluation (TCOPPE). Briefly, the TCOPPE project aimed to evaluate two state policies implemented to prevent childhood obesity: 1) the Safe Routes to School (SR2S) program and 2) the federal food allocation package distributed through Texas WIC. As part of the TCOPPE project, researchers examined the impact of policy changes – the revised WIC food packages (Institute of Medicine, 2006) – on availability, accessibility and affordability of healthy foods.

The WIC component of TCOPPE was designed as a cross-sectional study. The audit instrument, Texas Nutrition Environment Measures Survey (TxNEMS), was adapted from the Nutrition Environment Measures Survey (Glanz, 2007), and was used to determine the affordability, availability, acceptability, visibility, and WIC labeling of fruits, vegetables, whole grains, fruit juices, and milk in food stores. In addition, certain products of lower nutritional quality were assessed for comparison purposes.

The food stores selected for the TCOPPE study were based on the following criteria: 1) stores were recognized as a Texas WIC retailer/vendor in accordance with the Texas Department State Health Services, and 2) stores had to be located in an area where

field researchers were available for observational data collection. Additionally, stores had to be geographically dispersed throughout Texas and in neighborhoods with a high percentage of school-children eligible for free or subsidized lunches.

Stores were randomly selected based on their distance from the school that was selected as part of another component of the larger project. In other words, stores were selected within either a two-mile radius, a five-mile radius, or up to a 15-mile radius (for rural areas) from school sites. Large WIC retail stores (e.g., HEB or Super Wal-mart), medium-sized grocers (e.g., Brookshire or Fiesta Sellers' Bros.), and WIC-only vendors (small) were included in the sample.

The first set of data was collected in 2009, and the second set in 2011. This study utilized the second set of data in which 106 stores in 17 counties were audited. Although many health foods were examined, this study focused only on fresh fruits and vegetables. The fruits examined included apples, avocadoes, bananas, cantaloupe, grapes, oranges, peaches, and strawberries. The vegetables assessed included broccoli, carrots, corn, green beans, lettuce, potatoes, tomatoes, and summer squash. Thus, availability and affordability of fresh fruits and vegetables served as the outcomes of interest.

Measures

A composite score of total shelf width measurements (in inches) for all fruits and vegetables represented availability; and because measurements tended to be huge, this score was divided by 1000. Higher scores indicated more visibility, and more available foods. An additional composite score was created to represent affordability; this score

comprised prices for all fruits and vegetables. Less affordable foods had higher composite scores.

Because previous studies have observed differences in store size and availability and affordability of healthy foods, store size was included as a predictor (Bodor, 2008; Chung & Myers, 1999). For this study, the operational definition of store size was based on the store's volume of WIC eligible items. For example, large stores (such as Wal-mart) sell more WIC approved foods than medium stores (such as Brookshire).

Store size was a categorical variable that was dummy-coded prior to analysis, with large stores as the reference group. Location was a dichotomous variable (0=urban, 1=rural), which was categorized based on the county in which the stores were located. In this study, counties were rural if they were classified as any nonmetropolitan area that is divided into micropolitan areas centered on urban clusters (UCs) of 10,000 or more persons, and noncore counties (i.e., those not centered on urban clusters) (Ingram & Franco, 2012). Income was based on the county's median household income, which was obtained from the U.S. Census Bureau (2012).

Statistical Analysis

Hierarchical linear modeling, also known as multilevel modeling, was used to analyze data for food stores that were nested within counties. Models were conducted separately for the availability and affordability outcomes, and level-1 and level-2 predictors were examined. Store size (i.e., small, medium, large) served as the level-1 predictor. Location and county income served as the level-2 covariates.

Furthermore, hierarchical modeling was conducted in several phases, and a bottom-up approach, in which each variable was entered one at a time, was taken (Hox, 2010). An unconditional model (also the null model) in which no predictors were included was examined. Second, a random coefficient model was conducted in which the outcomes were predicted by first level predictors and slopes were allowed to vary randomly. Then, a random intercept model, which included county-level predictors location and income (which was grand-mean centered), was analyzed. Lastly, another random coefficient model was performed, and all level-1 and level-2 predictors were included. In addition, the intraclass correlation coefficients, which quantify the correlation between availability and affordability of fresh fruits and vegetables within communities, were calculated using variance estimates obtained from the multilevel models.

Inspection of missing data occurred prior to analysis. There were two types of missing data in this study: missing completely at random, such as out of stock items or items without measurements or miscalculated items (which was assessed by the project manager); and "missing data" such as food items that weren't carried in stores. The latter type of data was recoded to zero, which is meaningful since stores did not actually carry the items of interest. Missing data were excluded prior to running analysis, and all analyses were conducted using HLM software, version 7 (Raudenbush & Bryk, 2011). Assumptions of normality were tested by inspection of residuals (Hox, 2010).

Results

The descriptive statistics of the independent and dependent variables are shown in Table 3. Fifteen stores classified as rural, and the rest urban. The mean of the fruit and vegetable availability outcome was 19.60±3.29; for fruit and vegetable affordability, it was 3.21±2.10. The mean income at the county level was 46,287±1.01E4. Lastly, this study included 25 small stores (in terms of WIC volume), 37 medium-sized stores, and 44 large WIC retailers.

The assumptions of normality were met for the majority of the models; only the final model (model 4) did not meet the normality criterion. However, others have suggested that non-normality does not bias fixed effects parameters (Bernier, Feng, & Asakawa, 2011), therefore, no further corrections were conducted. Table 4 presents the multilevel results for availability of fresh fruits and vegetables. The results from the null model showed that the random term was statistically significant, and that there were county level differences. The intraclass correlation, or the proportion of availability of fresh fruits and vegetables across counties, was 0.38. The second model included the fixed effect terms for store size. This model indicated fruit and vegetable availability in medium sized stores was 0.95 inches higher relative to larger stores ($p<0.10$). Smaller stores also had more availability relative to larger stores, 1.97 inches more ($p<0.05$). However, the estimation of variance components showed that store size did not significantly vary among counties.

Table 3

Descriptive Statistics of Independent and Dependent Variables

Variable	*n*	%	Mean	Standard Deviation	Minimum	Maximum
FFV[a] availability			19.60	3.29	11.16	30.93
FFV affordability			3.21	2.10	0.26	10.30
Income			46287.0	1.01E4	32913.00	66152.00
Location						
Urban	90	84.9				
Rural	16	15.1				
Store size						
Small	25	23.6				
Medium	37	34.9				
Large	44	41.5				

[a]FFV = Fresh fruits and vegetables

Table 4

Availability of Fresh Fruits and Vegetables

Parameters	Unconditional	Level-1: random	Level-2: random	Level-1 and -2: random
Regression coefficients (fixed effects)				
Intercept	3.07**	1.93**	3.49**	2.11**
Large stores		-	-	-
Medium stores		0.95	-	1.04*
Small stores		1.98**	-	1.91**
Rural location			-1.94*	-1.10
Income			0.00	0.00
Variance components (random effects)				
Residual (σ^2)	2.76	2.39	2.75	2.34
Intercept (τ_{00})	1.72**	0.64	1.21**	0.09
Slope (τ_{11})		0.35		0.74
Slope (τ_{22})		0.08		0.58
Model summary				
Deviance statistic	413.79	394.83	424.47	406.91
Numbers of estimated parameters	3	7	5	9

**(p<0.001); *(p<0.05)

The third model incorporated the fixed effect terms for location and income. The regression coefficient for availability of fresh fruits and vegetables was -1.94 (p=0.05), resulting in less availability, even after controlling for county-level income. The fourth model included all level-1 and level-2 predictors. When all terms were added to the model, statistically significant results were only observed for medium and small sized stores. That is, there was more availability of fruits and vegetables in both medium- and small-sized stores.

The multilevel results for affordability of fresh fruits and vegetables are shown in Table 5. The null model indicated a statistically significant random term, that is, there were community level differences. The intraclass correlation was 0.33, and so 33% of the variance of affordability scores was at the county level. The second model showed fruit and vegetable affordability in medium-sized stores and smaller stores were not statistically different from that of larger stores. Final estimation of the variance components showed that these fixed effect terms did not significantly vary among counties; thus, no follow-up was needed.

The fixed effect terms for location and income are shown in the third model of Table 5. The regression coefficient for affordability of fresh fruits and vegetables was 3.70 ($p<0.05$), indicating less affordable foods (higher prices), even after controlling for income. However, when all predictors were added, as shown in the fourth model, these results became non-significant. The variance component showed a statistically significant difference in price among counties.

Table 5

Affordability of Fresh Fruits and Vegetables

Parameters	Unconditional	Level-1: random	Level-2: random	Level-1 and -2: random
Regression coefficients (fixed effects)				
Intercept	20.11**	20.60**	19.23**	20.05**
Large stores		-	-	-
Medium stores		0.02	-	-0.07
Small stores		-1.47	-	-1.19
Rural location			3.70*	2.34
Income			0.00	0.00
Variance components (random effects)				
Residual (σ^2)	7.12	6.40	7.17	6.68
Intercept (τ_{00})	3.69**	6.99	2.17**	5.60**
Slope (τ_{11})		0.17		0.36
Slope (τ_{22})		3.40		2.44
Model summary				
Deviance statistic	489.68	476.57	498.40	490.25
Numbers of estimated parameters	3	7	5	9

**(p<0.001); *(p<0.05)

Discussion

The purpose of this study was to examine the association between rural location of food stores with the availability and affordability of fresh fruits and vegetables that participants on WIC have access to. Do food stores in rural counties have less available and affordable fresh fruits and vegetables? Yes, when this is the only independent variable of interest as evidenced by the models shown in Tables 4 and 5. However, when other variables were controlled for, in terms of their impact on fruit and vegetable availability and affordability, the answer provided by the evidence in this study is no.

In terms of store size and availability and affordability, small stores had more fresh fruits and vegetables than medium- and large-sized stores. This is not unexpected given that store size was dependent on the volume of WIC eligible foods, and in this sample, small stores consisted of WIC-only vendors. Additionally, small stores had the highest prices for fresh fruits and vegetables, but this finding was not statistically significant. Future studies should look into the interaction effects of store size and rural location, which was not a focus of this study.

The data obtained were from TxNEMs, and TxNEMS was designed to assess the foods WIC participants had access to. Since the inception of the WIC program, fresh fruits and vegetables were not considered to be WIC eligible foods, however, changes to the WIC food packages now allow the purchase of fresh fruits and vegetables. The results of this study suggest variability at the county level when it comes to availability and affordability of fresh fruits and vegetables. And despite the changes in policy (i.e.,

WIC food package changes), changes in other levels of influence of health, such as rural food store environments, may not be immediate.

There are several limitations to this study. First, this study analyzed secondary data and data were not collected specifically for this study's research question. Second, there was not a large enough sample size, especially for the level-2 units. As such, the statistical power suffered in this study, and results should be interpreted with caution. Also, there were missing data. Some data were recoded to zero to reflect items that were not carried in stores, while others were missing completely at random. The percentage of data missing completely at random was low, at 5% for availability data and 8% for affordability data.

The TxNEMS examined food stores in different areas of Texas; such findings may not generalize to other study sites or other rural areas of the United States. Future research should include a larger sample of stores in different counties to examine the association between rural location and availability and affordability of fresh fruits and vegetables. Moreover, studies should assess whether availability and affordability is associated with consumer purchases and consumption and weight status.

Conclusions

Children who reside in rural locations have been shown to be disproportionately at risk for obesity. Excess weight among youth is often attributed to poor eating habits and physical inactivity. There are many ways to prevent childhood overweight and obesity, and studies suggest that consumption of fruits and vegetables may aid in prevention of weight gain. However, researchers have shown that rural areas tend to

have lack of access to healthy foods (Glanz & Yaroch, 2004; Kaufman, 1999; Variyam, 2001). This study provides evidence, albeit insufficient, to support this claim.

Through the use of hierarchical linear modeling, this study was able to show that food stores in rural counties were more likely to have less available and less affordable fresh fruits and vegetables. However, upon examination of all interested predictors, such results did not hold up.

CHAPTER V

CONCLUSION

Introduction

The prevention of childhood overweight and obesity has become a national priority, given that approximately 17% of American youth are obese (Ogden & Carroll, 2010). Childhood overweight and obesity has many established health, psychosocial, and economic consequences. A child's overweight status is often attributed to his/her dietary habits and physical inactivity, and these obesity-related behaviors are influenced by many factors on a micro- and macro-level.

Rural location may be a risk factor for youth overweight and obesity (Lutfiyya et al., 2007). However, what is not clear is *how and why* children of rural residency are at a higher risk for excess weight. This lack of understanding is critical because without it research, prevention and educational efforts aimed towards an important priority population are less likely to be effective.

The goal of this dissertation was to examine and understand how and why children may be more at risk for overweight and obesity in rural settings. In order to investigate this phenomenon, three separate manuscripts focused on the following: 1) an assessment of the current literature for determinants and mechanisms; 2) a meta-analysis of interventions for efficacy; and 3) an assessment of rural location on availability and affordability of fruits and vegetables.

Summary of Chapter II

In the first study, the systematic literature review focused on a simultaneous examination of multiple levels of influence with regards to children's obesity-related behaviors and weight status. Unfortunately, not many studies have studied the contextual facets of children's obesity-related behaviors and childhood obesity in rural settings. Data from four studies were extracted and qualitatively synthesized.

In general, lack of resources (ranging from low opportunities for physical activity and healthy eating to lack of easy access to primary care physician) and poverty within the rural environment impacted children's more immediate environment (school), social environment (parents/household), and individual factors such as motivation. However, there is still a lack of evidence in the literature as to the exact role of the rural environment in children's eating and physical activity behaviors that lead to overweight and obese status.

Summary of Chapter III

In the second study, interventions for prevention of childhood overweight obesity in rural settings were examined. Data from seven studies that met the inclusionary criteria were quantitatively assessed. The results suggest that interventions are efficacious, with small and modest effects.

Further analyses show that certain characteristics moderate mean intervention effects, including duration of intervention and mean age of children. Interventions that

were implemented in younger children and with a shorter duration tended to increase mean intervention effect size.

Summary of Chapter IV

In the last study, multilevel modeling was used to examine food stores in rural counties and their association with availability and affordability of fresh fruits and vegetables using secondary data – the TxNEMS. When rural location was analyzed as the sole predictor, results showed that food stores in rural counties were more likely to have less available and less affordable fresh fruits and vegetables. When all predictors were examined, results were not sustained. However, a larger sample size is needed in order to conclude if rural location impacts availability and affordability of fruits and vegetables.

Discussion

Limitations

To date, the U.S. government defines childhood overweight and obesity in terms of body mass index, BMI (Barlow, 2007). Children of the same age and sex are considered overweight if their BMI is at or above the 85th percentile and lower than the 95th percentile, while obese children have a BMI at or above the 95th percentile. A limitation in using these designations is that changes in the overall population will eventually lead to changes in the thresholds for these criteria. However, others have noted that BMI remains to be a reliable measure of children's weight status (Cole et al., 2005).

Limitations to each study must be noted. For example, in the first study, the narrow focus of the research question required a rigid set of criteria. As a result, 74% of the articles identified through the systematic search were excluded based on studies excluding children or any measure of overweight, and not being conducted in rural United States. In addition, most studies were qualitative, and did not provide information on children's actual health behaviors. Also, the qualitative studies included a small sample of parents, so it may be possible that not all concerns were expressed. Furthermore, the quantitative study included in the review relied on parent-reported data, which can potentially suffer from social desirability bias. Another limitation was the use of a single reviewer, which introduced the likelihood of reviewer bias.

For the second study, a small sample of studies was obtained, and results should be interpreted with caution. In addition, the studies included in the meta-analysis had insufficient data that did not allow for further analyses. Demographic characteristics, such as participants' ethnicity and sex, were important variables to examine. Other missing data included confidence intervals or standard deviations of main outcome measures. Although calculations can be used to estimate effect sizes, it is still essential for researchers to report standard deviations and confidence intervals. Additionally, similar to the first study, the use of a single reviewer/meta-analyst served as a limitation.

Limitations to the third study revolved around the use of secondary data. Thus, the data were not specifically collected to answer the study's research question. In addition, since data were already collected, sample size was fixed and was not large enough to achieve statistical power. Additionally, there was the issue of missing data,

however, only 8% of the affordability and 5% of the availability data were missing and excluded from the analysis.

A note on missing data is warranted. As with all research, missing data and how to deal with them can be an issue. There are many types of missing data: missing completely at random, missing at random, and missing not at random. Interested readers can read about the differences elsewhere (Little & Rubin, 1987; Streiner, 2002). Ways to handle missing data include dropping variables, imputation, or listwise deletion among others (Howell, 2009; Streiner, 2002). In the case of hierarchical linear modeling, listwise deletion is often the choice, that is, to omit cases with missing data prior to conducting analysis. Listwise deletion does not bias parameter estimates provided that data are missing completely at random (Howell, 2009).

Contributions to the Literature

Each study had its own unique contribution to the current literature, and as a whole this dissertation focused on an area of research that is understudied. In regards to chapter II, a systematic review exploring physical, social, and individual factors that impact children's obesity-related behaviors simultaneously has not yet been conducted. This study proved that there continues to be a lack of studies that focus on environmental influences that might interact with individual factors (Story et al., 2008). The inclusion of several levels of influence for examination is crucial, especially one that incorporates the child's personal factors such as motivation.

Regarding chapter III, current interventions with children in rural settings result in modest weight loss effects. This may be a contributing factor as to why rural children

are disproportionately at risk for being overweight. However, an examination of interventions in other settings for comparison is needed in order to conclusively state that geographic disparities exist.

Lastly, with respect to chapter IV, results of multilevel modeling showed that rural location may impact availability and affordability of fresh fruits and vegetables, which ties into chapter II's theme of lack of resources. The application of multilevel models is unique because it takes into account contextual levels that exist, thus, more accurately modeling the relationships between outcome and predictors.

Implications for Public Health Education

The area of rural childhood obesity is rife with opportunities for public health and health education. Health educators can play a role in the promotion of and advocacy for environmental conditions that are supportive of healthy lifestyles. Findings from this dissertation suggest that lack of resources and poverty are prevalent in the rural environment, which indirectly impact children's behaviors that lead to overweight and obesity. Also, interventions to prevent weight gain among children have achieved small effects, potentially exacerbating the problem. Solutions to these problems, such as policy recommendations for better access to and more affordable healthy foods and interventions for weight control and healthy lifestyles with young children, may help to alleviate the burden of childhood overweight and obesity.

Recommendations for Future Research

The findings from this dissertation can serve as a basis for further exploration into potential differences between urban and rural residing children. For example, in

terms of the first and second study, future studies can examine the literature focusing on childhood overweight and obesity in urban settings and interventions for this group. Furthermore, with respect to the third study, a follow-up study can utilize the grocery store audit instrument to investigate rural-urban differences in availability and affordability of healthy foods in conjunction with an assessment of where WIC participants purchase food, what they purchase, and their consumption and child feeding practices. Thus, such a study may provide evidence for the causal mechanism of an environmental attribute to a health outcome.

Gaps in the literature still remain. Other researchers have concluded that little is known about the mechanisms of interaction between environmental, social, and individual factors that lead to overweight and obesity risk (Ball, Timperio, & Crawford, 2006; Story et al., 2008). What mediates specific environmental factors that might interact with individual factors to influence eating and physical activity behaviors in children? Future research should investigate this problem using theory as a guide for careful selection of key environmental factors to examine.

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APPENDIX A

RUSSELL AND GREGORY'S EVALUATION OF METHODOLOGICAL QUALITY

1. Is the research question clear and adequately substantiated?
   Yes No

2. Is the design appropriate for the research question?
   Yes No

3. Was the method of sampling appropriate for the research question and design?
   Yes No

4. Were data collected and managed systematically?
   Yes No

5. Were the data analyzed appropriately?
   Yes No

APPENDIX B

JBI CRITICAL APPRAISAL OF EVIDENCE EFFECTIVENESS TOOL

1. Was the assignment to treatment groups random?
   Yes No Not clear NA

2. Were participants blinded to treatment allocation?
   Yes No Not clear NA

3. Were the outcomes of people who withdrew described and included in the analysis?
   Yes No Not clear NA

4. Were those assessing the outcomes blinded to the treatment allocation?
   Yes No Not clear NA

5. Were control and treatment groups comparable at entry?
   Yes No Not clear NA

6. Were groups treated identically other than for the named interventions?
   Yes No Not clear NA

7. Were outcomes measured in the same way for all groups?
   Yes No Not clear NA

8. Were outcomes measured in a reliable way?
   Yes No Not clear NA

9. Was there adequate follow-up of participants (>80%)?
   Yes No Not clear NA

10. Was appropriate statistical analysis used?
   Yes No Not clear NA

APPENDIX C

LIST OF SUBSTANTIVE AND METHODOLOGICAL VARIABLES AND CODED VALUES

#	Variable Name	Label Name	Value Label
1	studyid	Study Id number	
2	pubtype	Journal article	0= no 1= yes
3	pubyear	Publication year	
4	peerview	Peer-reviewed document	0= no 1= yes
5	meanage	Mean age of sample	
6	conage	Mean age of control group	
7	expage	Mean age of experimental group	
8	grade	Grade level of sample	1=preschool/daycare 2=kindergarten 3=1st-6th
9	race	Predominant race	1= >60% white 2= >60% black 3= >60% hispanic 4= >60% other minority 5= mixed, none more than 60% 6= mixed, cannot estimate proportion 9= cannot tell
10	sex	Predominant sex	1= >50% male 2= >50%% female 9= cannot tell
11	typeint	Type of intervention	1= diet 2= physical activity 3= school curriculum 4= environmental change 5= health-related community service 6= behavior modification

			7= parental involve 8= mixed, two or more types 9= cannot tell
12	theory	Theoretical orientation	0= not based on theory 1= based on theory 9= cannot tell
13	lengthinter	Length of intervention (in weeks) Weight of children at onset of intervention	
14	setting	Intervention setting	1=intrapersonal 2= home/family (interpersonal) 3= school-based (organizational) 4= community-based 5= policy 6= mixed, two or more levels involved
15	design	Type of design	1= randomized controlled trial 2= cross-sectional 3= quasi-experimental 4= other specify
16	primeout	Primary outcome	1= BMI 2= Weight in pounds 3= % body fat 4= skin fold measurement 5=hip to waist ratio

Effect Size Coding

#	**Variable Name**	**Label Name**	**Value Label**
17	es	Effect size measure	1= pretest 2= posttest 3= follow-up

18	estype	Effect size type	1= means and standard deviation 2= t-value or F 3= chi-square 6= other (specify)
19	totaln	Total sample size	
20	intN	Intervention group sample size	
21	conN	Control group sample size	
22	intmean	Intervention group mean	
23	conmean	Control group mean	
24	intSD	associated standard deviation of intervention group	
25	conSD	associated standard deviation of control group	
26	fvalue	F statistic	
27	d	Cohen's d	
28	hedgeg	Hedges g value	
29	w		
30	wg	weighted g	

APPENDIX D

TABLE OF CALCULATED EFFECT SIZES

Study Year	**Authors**	**Outcomes**	**Statistic Type**	**Mean Con**	**Mean Exp**	**SD Con**	**SD Exp**	**N Con**	**N Exp**	**N**	**Summary Statistic**	**Computation**	**Cohen's *d***
2005	Carrel	BMI		0	1	4	6	23	27	50		5.180	-0.19
2004	Dennison	BMIZ		0.37	0.19	0.21	0.21	34	43	77		0.210	0.86
1996	Donnelly	BMI		1.2	1	2.6	3.8	64	44	108		3.143	0.06
2011	Greening	BMI percentile	F-statistic					140	114	254	2.41	0.196	0.20
2008	Janicke	BMIZ		-0.012	-0.078	0.15	0.16	21	24	45		0.155	0.42
2008	Janicke	BMIZ		-0.012	-0.139	0.15	0.19	21	26	47		0.173	0.73
2011	Smith	BMI percentile		-0.071	-0.379	1.25	0.93	29	32	61		1.094	0.28
2011	Williamson	BMIZ		0.07652	0.01995	1.12	1.22	587	713	1300		1.176	0.05
2011	Williamson	BMIZ		0.07652	0.0634	1.12	1.13	587	760	1347		1.126	0.01